

# Environmental Protection Agency

## **Calibration and Verification of Digital Barometers Procedure**

This procedure is written for the Environmental Protection Agency, National Vehicle and Fuel Emissions Laboratory (NVFEL) internal use. The use of specific brand names by NVFEL in this procedure are for reference only and are not an endorsement of those products. This document may be used for guidance by other laboratories.

### **NVFEL Reference Number**

213C

### **Implementation Approval**

Original Procedure Authorized by EPCN #168 on 08-11-94

### **Revision Description**

- (1) 09-30-94 The purpose of this change is to revise the procedure as described in EPCN #170.

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**1. Purpose**

This procedure describes the calibration and verification of Bell and Howell and Mensor digital barometers.

**2. Test Article Description**

The Bell and Howell and Mensor digital barometers measure atmospheric pressure and provide a digital display on the front panel in inches of mercury. The output of the digital barometer used by Vehicle Testing (VT) is wired to the Laboratory Computer System (LCS).

**3. References**

- 3.1 Bell and Howell Digital Barometer Instruction Manual (located in the Electronics Shop Office)
- 3.2 Mensor Digital Barometer Operation and Maintenance Manual (located in the Electronics Shop Office)
- 3.3 Princo Standard Mercurial Barometer Instructions and Correction Tables (located in the Gas Blending Lab)
- 3.4 Barometer Test Unit Diagram, see Attachment A

**4. Required Equipment**

- 4.1 Princo Standard Mercurial Barometer (located in the Gas Blending Lab)
- 4.2 Barometer Test Unit
- 4.3 Form 213-01, Digital Barometer Calibration Sheet, see Attachment B
- 4.4 Form 213-02, Digital Barometer Verification Sheet, see Attachment C

**5. Precautions**

Avoid removing the digital barometer case unless it becomes necessary to perform troubleshooting and/or corrective maintenance.

**6. Visual Inspection**

Visually check all plumbing connections, electrical connections, and the digital display for abnormal conditions before proceeding with any calibration or verification procedure. Ensure that the digital barometer sensor inlet is free of obstructions.

**7. Test Article Preparation**

Place the barometer test unit close to the barometer so fitting F1 (see Figure 1) can be connected to the input pressure fitting of the barometer. Ensure that the water level on both sides of the manometer “U” tube reads zero.

**8. Test Procedure**

This procedure consists of two parts which may be performed in sequence or separately:

**100 Calibration**

Performed monthly or after maintenance and repair work.

101 Verify that the barometer power has been on for a minimum of 1 hour.

102 Read the Princo standard mercurial barometer, located in the Gas Blending Lab, to the nearest 0.01 inch of mercury. Apply temperature and gravity correction factors as defined on Form 213-01.

Record these data as “PB” on Form 213-01.

103 Verify that the digital barometer agrees within 0.03 inch of mercury of the corrected mercury column reading.

If the reading does not agree, recheck the Princo mercurial barometer reading and ensure that the inlet fitting of the digital barometer is free of obstructions.

If the reading still does not agree, Electronics Shop personnel should remove the unit from the case and adjust the span and zero pots to correct the reading. Consult the appropriate digital barometer instruction manual for additional information on these adjustments.

104 Refer to the diagram of the barometer test unit while performing Steps 104 through 124 of the calibration (see Attachment A, Figure 1). Place shut-off valves V1 and V2 of the barometer test unit in the open position.

- 105 Connect fitting F1 of the barometer test unit to the digital barometer input pressure fitting.
- 106 The manometer should read zero and the digital barometer should read atmospheric pressure.
- If they do not, check the positions of valves V1 and V2.
- 107 Record the digital barometer reading as “PA” on Form 213-01.
- 108 Pull the syringe plunger out 4 inches.
- 109 Turn valve V1 to the closed position.
- 110 Slowly push the syringe plunger in until the manometer reads approximately 18 inches of H<sub>2</sub>O ( $\pm$  2 inches).
- 111 Turn valve V2 to the closed position.
- 112 Record the reading of the digital barometer as “P1” in the +•P column of Form 213-01.
- 113 Record the reading of the manometer as “P2” in the +•P column of Form 213-01.
- 114 Turn valve V2 to the open position.
- 115 Turn valve V1 to the open position.
- 116 The manometer should read zero and the digital barometer should read atmospheric pressure.
- If they do not, check positions of valves V1 and V2.
- 117 Push the syringe plunger all the way in.
- 118 Turn valve V1 to the closed position.
- 119 Slowly pull the syringe plunger out until the manometer reads approximately 18 inches of H<sub>2</sub>O ( $\pm$  2 inches).
- 120 Turn valve V2 to the closed position.

- 121 Record the reading of the digital barometer as “P1” in the -•P column of Form 213-01.
- 122 Record the reading of the manometer as “P2” in the -•P column of Form 213-01.
- 123 Perform the calculations shown on Form 213-01 for the +•P and -•P tests. The difference between the digital barometer reading and the calculated absolute pressure must be less than or equal to 0.03 inches of mercury.
- If it is not, corrective action must be initiated before the unit can be used for testing.
- 124 Disconnect fitting F1 of the barometer test unit from the digital barometer.

**200 Verification**

Performed weekly.

- 201 Perform Steps 101 and 102 of the calibration procedure. The digital barometer must agree within 0.05 inch of mercury of the corrected mercury column (PB). Record the data on Form 213-02.
- If the instrument is out of tolerance, perform the complete calibration procedure, Steps 101 through 124.
- 202 Compare the digital barometer reading and the Laboratory Computer System reading for each VT test site.
- If the readings at any site differ by more than 0.01 inch of mercury, notify Computer Group personnel.

**9. Data Input**

All data and calculations are documented on Form 213-01 or 213-02.

**10. Data Analysis**

Calculations indicated on Forms 213-01 and 213-02 are performed by the technician.

**11. Data Output**

The team leader reviews Forms 213-01 and 213-02 to assure complete documentation and accuracy.

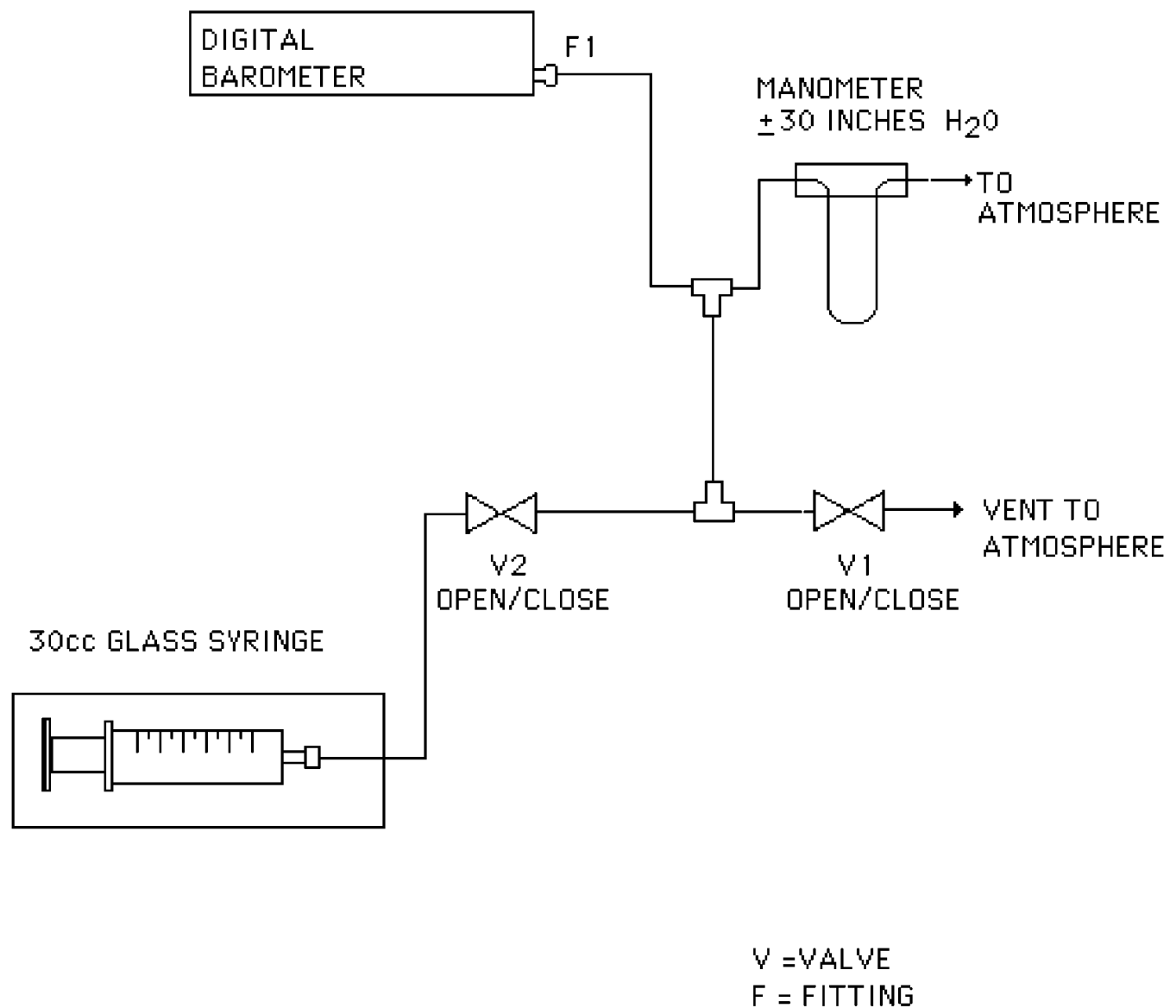
**12. Acceptance Criteria**

The digital barometer must read within 0.03 inch of mercury of the absolute pressure in a range of 27-31 inches of mercury for the calibration and within 0.05 inch of mercury of the corrected mercury column (PB) for the verification.

**13. Quality Provisions**

- 13.1 The log sheet used for recording the data is signed and dated by the technician performing the calibration or verification.
- 13.2 Comments that describe any problem diagnosed or maintenance performed are included on Form 213-01 or 213-02.
- 13.3 The C&M Manager initials the log sheet after reviewing it and initiates corrective action when necessary.
- 13.4 The technician performing the calibration or verification ensures that the barometer case is kept free of dirt and dust.

## Attachment A

BAROMETER TEST UNIT**Figure 1**



## Attachment B

DIGITAL BAROMETER CALIBRATION SHEET

DATE \_\_\_\_\_ PROP. ID. \_\_\_\_\_  
 INST. SER.# \_\_\_\_\_ TECH. \_\_\_\_\_  
 ROOM# \_\_\_\_\_ TEAM LDR. INIT. \_\_\_\_\_

☐ BOX DENOTES WHICH STEP OF TEST  
 PROCEDURE TO PERFORM.

BAROMETER CORRECTION FACTOR TABLE										
ALT.=900FT., AVG. BAR.=29.00" HG, LAT.=42.3° N										
TEMP.	68	70	72	74	76	78	80	82		
CF	0.111	0.117	0.122	0.127	0.132	0.137	0.143	0.148		
OBSERVED BARO READING = _____ "HG CORRECTION FACTOR (MINUS) = _____ "HG CORRECTED BARO PB = _____ "HG DIGITAL BARO READING PA = _____ "HG DIFFERENCE (PB-PA) = _____ "HG										
DATA ITEM	DATA DESCRIPTION									
									+ Δ P	
									- Δ P	
P1	DIGITAL BAROMETER								"HG 113	"HG 122
P2	U - TUBE MANOMETER READING								"H2O 114	"H2O 123
P3	CONVERT P2 TO "HG P3 = (0.07369 X P2)								"HG	"HG
P4	CALCULATE ABSOLUTE PRESSURE P4 = PB + P3								"HG	"HG
	P1 - P4								"HG 124	"HG 124

ACCEPTANCE TOLERANCE: DIFFERENCE OF P1 AND P4 MUST BE LESS THAN OR EQUAL TO 0.03" HG.

COMMENTS: \_\_\_\_\_

## Attachment C

**DIGITAL BAROMETER VERIFICATION SHEET**

DATE \_\_\_\_\_  
TECH. \_\_\_\_\_  
TEAM LDR. INIT. \_\_\_\_\_



BOX DENOTES WHICH STEP OF TEST  
PROCEDURE TO PERFORM.

BAROMETER CORRECTION FACTOR TABLE

ALT.=900FT, AVG. BAR.=29.00"HG, LAT.=42.3 ° N

TEMP.	68	70	72	74	76	78	80	82
CF	0.111	0.117	0.122	0.127	0.132	0.137	0.143	0.148

OBSERVED BARO READING = \_\_\_\_\_ "HG 102  
CORRECTION FACTOR (MINUS)= \_\_\_\_\_ "HG  
CORRECTED BARO PB = \_\_\_\_\_ "HG

INST. SER# \_\_\_\_\_  
ROOM# \_\_\_\_\_

DIFFERENCE (PB-PA) = \_\_\_\_\_ "HG

201

INST. SER# \_\_\_\_\_  
ROOM# \_\_\_\_\_

DIGITAL BARO READING PA = \_\_\_\_\_ "HG

INST. SER# \_\_\_\_\_  
ROOM# \_\_\_\_\_

DIFFERENCE (PB-PA) = \_\_\_\_\_ "HG

INST. SER# \_\_\_\_\_  
ROOM# \_\_\_\_\_

DIGITAL BARO READING PA = \_\_\_\_\_ "HG  
DIFFERENCE (PB-PA) = \_\_\_\_\_ "HG

INST. SER# \_\_\_\_\_  
ROOM# \_\_\_\_\_

DIFFERENCE (PB-PA) = \_\_\_\_\_ "HG

INST. SER# \_\_\_\_\_  
ROOM# \_\_\_\_\_

DIGITAL BARO READING PA = \_\_\_\_\_ "HG  
DIFFERENCE (PB-PA) = \_\_\_\_\_ "HG

INST. SER# \_\_\_\_\_  
ROOM# \_\_\_\_\_

DIGITAL BARO READING PA = \_\_\_\_\_ "HG

INST. SER# \_\_\_\_\_  
ROOM# \_\_\_\_\_

DIGITAL BARO READING PA = \_\_\_\_\_ "HG

INST. SER# \_\_\_\_\_  
ROOM# \_\_\_\_\_

DIFFERENCE (PB-PA) = \_\_\_\_\_ "HG

INST. SER# \_\_\_\_\_  
ROOM# \_\_\_\_\_

DIGITAL BARO READING PA = \_\_\_\_\_ "HG

COMPARISON OF LARGE SOAK DIGITAL BAROMETER TO LCS PRINTOUT.

202

LARGE SOAK DIGITAL BAROMETER READING \_\_\_\_\_ "HG  
BARO READING FROM SITE A001 LCS PRINTOUT \_\_\_\_\_ "HG DIFF \_\_\_\_\_ "HG  
BARO READING FROM SITE A002 LCS PRINTOUT \_\_\_\_\_ "HG DIFF \_\_\_\_\_ "HG  
BARO READING FROM SITE A003 LCS PRINTOUT \_\_\_\_\_ "HG DIFF \_\_\_\_\_ "HG

ACCEPTANCE TOLERANCES : DIFFERENCE OF PB AND PA MUST BE LESS THAN OR  
EQUAL TO 0.05" HG. LCS PRINTOUT MUST BE WITHIN  
0.01" HG OF LARGE SOAK DIGITAL BAROMETER READING.

COMMENTS \_\_\_\_\_